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The Life-History of Micro-Organisms,  
with its Relation to the Theory  
of Evolution.

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PROF. PHYSIOLOGY AND CLINICAL SURGERY IN HOWARD UNIVERSITY, WASHINGTON, D. C.

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# The Life-History of Micro-Organisms, with its Relation to the Theory of Evolution.\*

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It is the distinguishing characteristic of a hitherto unknown law of nature, that it brings into harmony and order many isolated facts that before its discovery seemed to have no connection with each other. Such a law of nature, to the great majority of the scientists of the present day, the theory of evolution has seemed to be. There is a dazzling simplicity in this hypothesis of the genesis of all organic forms that is very attractive to the imagination. To believe that all living organized existences have been produced from a few masses or particles of living protoplasm, by the forces of natural selection and the conditions of their environment, is indeed solving the mystery of the universe as easily as a child, by the aid of the letters of the alphabet, masters the words of his mother-tongue.

But when in a spirit of calm and scientific inquiry we proceed to study these problems, we do not find them quite so easy of solution as the theory of evolution would seem to indicate. Difficulties and doubts arise that must be overcome before we can accept it.

The life-history of micro-organisms should throw light on these questions; many of them are composed of small particles of germinal matter, or protoplasm, without either the nuclei, cell walls, or cell contents, that are found in what are ordinarily known as cells in living organisms. Before our eyes and on the stages of our microscopes, we can study them to our hearts' content. We can watch them multiply either by the development of ova (or eggs), by gemmation (or budding), by fission (or division), or by the production of alternate or successive generations.

The first question to be answered concerning these microscopic organisms is the natural query, Whence came they? To this question evolution gives no answer.

Just as impassable as it was before the invention of the microscope is the yawning gulf that divides living protoplasm from dead matter. We can start on our argument to-day with the axiom, *Omnia vivum ex ovo* (every living thing has sprung from an egg or germ), with just as much assurance of its truth as when it was first enunciated by the great philosopher. Yea, even more so, for time and increased knowledge have only accumulated evidences of its truth.

When the biologist of to-day makes a pure culture of a living organism, and places it with the proper precautions, in a pure medium or soil fitted for its growth, he invariably finds, and expects to find, the same organism growing under his eyes, or on the stage of his microscope. He no more finds, or expects to find, a different organism resulting, than a horticulturist would find grapes growing upon an apple

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tree or thistles upon a plum tree. In regard to the theory of spontaneous generation, or the spontaneous formation of living organisms, from dead matter, it is only necessary here to say, that it is almost universally abandoned by all biologists of any eminence. This theory has been destroyed by the labors and investigations of many scientists, more especially by the elaborate and long continued experiments of Prof. Tyndall, of England.

Thousands of persons in various parts of the world find remunerative employment in putting up for table use meats, fish, fruits, and other perishable articles of food by what is known as the canning process. In this method of preserving food, the tin cans or other receptacles are placed in watery solutions of various salts, which boil at a temperature considerably above the temperature of boiling water; by being treated in this way the living germs in them become destroyed, and they become sterilized; whilst in this condition and whilst the steam is still escaping from the can, the opening is dexterously closed by a drop of solder. These cans all contain articles of food, which would be utterly destroyed and made putrid by exposure for a few days, or even hours, to the atmospheric air. The traveller in the arctic regions, or in the wilds of tropical Africa, if the cans are uninjured, expects to find the contents fit for table use, even when they have been kept for years.

Men who know nothing of science are willing to invest millions of money in the various industries concerned in the preservation of foods, with a firm faith that their capital is safely and profitably invested. This could not be the case if the spontaneous generation of the micro-organisms, which cause fermentation and putrefaction, were possible.

The life-history of micro-organisms when considered with regard to their rapidity of multiplication, presents a field of study which should give us valuable information with regard to the truth of the theory of evolution. It is very probable, and indeed very certain, that the study of a bacterium and its progeny for a few days gives us a series of generations more numerous than have existed among the higher classes of animals since the earth was fitted for their habitation. The rapidity of the growth and multiplication of bacteria is as far beyond the capacity of the human mind to conceive, as it is to attempt to measure the distances of the stars in the heavens, or to count their numbers.

Professor Buckner, of Germany, states the time usually required for one microbe or germ to become two, by the process of division, is fifteen minutes. At this rate it is computed that a single microbe would produce in twenty-four hours a million million million times the present human population of the earth. Professor Law, in a paper published recently in the *Pharmaceutical Era*, estimates that a single bacterium dividing and redividing would produce in forty-eight (48) hours, if undisturbed, 281,500,000,000, and in bulk would fill a half-pint measure, all produced in two days, from a single germ measuring the  $\frac{1}{150000}$  part of an inch.

Pathological bacilli are just as numerous where found, and divide as rapidly. Professor Böllinger states that a cubic-centimeter (about one-fourth of a fluid drachm) of phthisical sputum (from a case of pulmonary consumption) contains from 810,000 to 960,000 tubercle bacilli.

In an ordinarily copious expectoration the consumptive patient deposits nearly a million bacilli into his cup, and in an ordinary day he throws 30 or 40 millions of these micro-organisms into the world. Then, at a low estimate, ten thousand tuberculous patients, now living in New York city, daily expectorate some 300,000,000,000 tubercle bacilli.

If, as the theory of evolution presupposes, that there is really no such thing as a distinct species—a species being only a stepping-stone between a lower and a higher organism, in its upward progress of development—we should find in these minute organisms transitional forms shading into each other on every side. But as our knowledge becomes more complete of these organisms, we find that this is not the case. In fact, we find just as distinct morphological characteristics in the lower organisms as in the higher classes of animals. Over one hundred species of micro-organisms are now said to be known, which either cause or find their appropriate habitat in pathological conditions existing in man and the higher classes of animals. Many of these have been so thoroughly studied that we know their life-history just as accurately as we know that of the lion of Africa or the elephant of India.

When a biologist sows with proper precautions a pure culture of bacillus anthracis (The Bacillus of Anthrax or Charbon), does he ever get a progeny of bacillus tuberculosis? Or if he plants the germs of bacillus tuberculosis, does he ever produce the straphylococcus pyogenes aureus (or organism which causes the formation of pus)? Most assuredly not.

It is perfectly true that, by the microscope alone, it is difficult and sometimes impossible to distinguish between the different forms of micro organisms. Each, however, can be identified in some way, either by its color, or form, or habitat, or method of growth. One micro organism thrives in bouillon, another in gelatine, another in agar agar; one grows in small colonies of germs, another in single rows; some liquefy the gelatine or agar agar in which they grow, others do not. The more we study these minute organisms the more we are struck by their characteristic differences from each other. No more striking exemplification can be given of the value to mankind of scientific facts than is presented in the growth and development of the modern aseptic or, as it is often called, the Lister method of surgery.

The discoverer of the fact that certain minute organisms almost always found in the atmosphere, and which by their presence produce pus and septic poisoning, could scarcely have ever imagined the grand consequences and blessings to mankind that would result from it. By excluding from wounds and injuries these poisonous germs, surgery in our day has been completely transformed, and the gravest operations of surgery robbed of almost all of their terrors. One operator, Mr. Lawson Tait, of England, has operated for the removal of tumors from the abdomen over two thousand (2,000) times, and with a mortality that is steadily diminishing. In this last series of one thousand cases he reports an average mortality of  $5\frac{3}{10}$  per cent.—in other words he has succeeded in saving from certain death nearly ninety-five (95) out of one hundred (100) persons operated upon by him. This whole superstructure of modern surgery is built upon the laws controlling the growth of micro-organisms, and their unchanging methods of development.



Probably the most beneficent gift that the science of medicine ever gave to mankind was Dr. Jenner's great discovery of vaccination as a preventative of small-pox. During past centuries small-pox spared no rank or station in society, from the monarch in his kingly robes, to the beggar in his rags; all felt the power and virulence of this dread destroyer. This deadly and fearful scourge has been destroyed by the growth on the surface of the human body of a micro-organism found in the vaccine virus. During the two hundred and twenty (220) years that have elapsed since Jenner's discovery, how many millions upon millions of men upon this earth have been vaccinated, and with precisely the same result! Has the micro-organism of the vaccine virus changed its appearance during that time, or altered in its power for good? Not a particle.

We plant this germ in the arm of a child, and on the third or fourth day we see on the place a vesicle (or little blister) arise filled with a clear, watery fluid, this afterwards becomes milky and then yellow in color; coincident with this, the vesicle or pustule becomes changed in shape, it becomes what is called umbilicated, or depressed in the centre of its upper surface. These special changes in shape and growth distinguish the vaccine pustule from an ordinary pimple or sore. Every case of vaccination with pure vaccine virus passes through this life-history just as perfectly as it did in the days of Jenner, and, so far as we can judge from the past, will do so till the end of time.

But we can go still farther back in time for illustrations of the perpetuity of micro-organisms. Early in the world's history some of the earlier races of mankind were in the habit of performing a rough method of trephining by scraping with the sharpened edges of shells or flints the skulls of certain persons. These skulls show attempts at repair, and also in some a carious or necrosed condition of the surrounding bones; in others, bones of the body have been fractured and repaired in just the same way as if the injuries had been inflicted in our day.

As the same phenomena attended the injuries and repair of these skulls and other bones as are found to-day, is it not logical to assume the existence at that remote period of the same micro-organisms that cause these conditions now? But we can go still farther back in this matter; some of the earlier remains of fossil fishes show injuries of bones with repair, and can we not fairly make the same assumption for them? If this be indeed so, it would make the life-history of some micro-organisms so ancient as to render the time that man has lived upon the earth insignificant by comparison.

To recapitulate, the following statements seem to be true:

1. Micro-organisms have their life-history and morphological characteristics just as definitely as the higher organisms.
2. Micro-organisms retain their individuality of species, and do not change into each other.

If the above statements shall prove to be true, they seem to be incompatible with the truth of the theory of evolution.



